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Main Problems in the Control of Scientific and Technological Creative Activities, Application of Innovations and Education of Scientific Staff: Based on the Policy in Science of the Polish People's Republic

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MAIN PROBLEMS IN THE CONTROL OF SCIENTIFIC AND TECHNOLOGICAL CREATIVE ACTIVITIES, APPLICATION OF INNOVATIONS AND EDUCATION OF SCIENTIFIC STAFF
Based on the Policy in Science of the Polish People's Republic

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PREFACE

This paper was presented at the opening plenary session of the Conference on "Management of Research, Development and Education" organized jointly by the Forecasting Research Center of the Technical University of Wroclaw, Poland and the Management and Technology Area of IIASA, and held in Wroclaw in September 1978. It was felt that in view of its general interest to scientists and scientific policy makers it should be made separately available as an IIASA collaborative paper. A selection of the other papers presented at the conference is given in IIASA CP-80-18.

Professor J. Kaczmarek is Scientific Secretary of the Polish Academy of Sciences, and the Polish representative on the IIASA Council.

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GENERAL INTRODUCTION

This paper is one of two IIASA Collaborative Papers containing papers presented at the Third International Conference on the Management of Research, Development and Education held at Wroclaw, Poland in September 1978. The conference was, on this occasion, jointly organized by Dr. Karol Pelc, Director of the Forecasting Research Center of the Technical University of Wroclaw and by Professor Gennady Dobrov, Deputy Director, Institute of Cybernetics, Kiev and at that time a member of the staff of the Management and Technology Area of the International Institute for Applied Systems Analysis. Formally, it was jointly sponsored by the Wroclaw Technical University and IIASA.

It is always difficult to decide what to do about conference proceedings. The greatest value of such conferences is usually the meeting between minds--the exchange of information and understanding between people from different cultures and academic backgrounds. This was particularly true at the Wroclaw conference where there was strong representation from ten countries, both East and West. It was a rare opportunity for scientists to identify potential collaborators and discover who was working in which field. Such opportunities are too few. Nevertheless, the Conference Scientific Committee felt that a number of the papers should be made available for reference in a more accessible form, and with their help, we have made a selection for issue as IIASA Collaborative Papers. The present paper, which opened the Conference, is of wider interest and is therefore published separately. Thirteen further papers are collected together in CP-80-18. A complete list of the 40 papers read at the conference are given as an Appendix to that collection--copies of individual papers can be obtained by request from the Forecasting Research Center, Technical University of Wroclaw.

All the papers presented in these two Collaborative Papers are as given at the conference. In the interests of economy we have not attempted to edit them in any way.

We would like to take this opportunity of thanking the members of the Scientific Committee of the conference for their help with regard to the conduct of the conference and the subsequent selection of papers for publication. It was another example of successful international cooperation.

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MAIN PROBLEMS IN THE CONTROL OF SCIENTIFIC AND TECHNOLOGICAL CREATIVE ACTIVITIES, APPLICATION OF INNOVATIONS AND EDUCATION OF SCIENTIFIC STAFF

Jan Kaczmarek

1. ON PROBLEMS OF CONTROLLING THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY

While approaching the development of human societies from the historical point of view over a long period of time one can see that this development depends strictly on the growth of human intellect, objective understanding of the surrounding world and practical utilization of collected knowledge. It is beyond any doubt that it is intellect that plays the main role in this development.

This is possible to state in brief that the development of mankind is determined by the development and use of intellect.

Due to prominent discoveries of science and their numerous and massive use in technology, production and services, it was realized throughout the world that science and its affairs are the domain not only of scientists but of entire societies, nations and mankind.

Thus, the contemporary problem of interrelation between science and the development of life is reduced to the question whether it is possible and necessary to control R+D and how to do this to obtain a positive catalysis of scientific activity and its optimal influence on the progress in civilization and human culture.

In the multiplicity of opinions on this matter all over the world the role of organization is the thing which is commonly accepted and so the role of controlling creative activities in science and technology.

Organization of societies which has been derived from social and political ideology can either speed up or slow down the use of the development of intellect. This is taught by history, particularly the modern history of rapidly developing countries.

From this observation, there emerge many questions: how to develop human intellect within the framework of education; what catalysts should be used for promoting objective cognitive processes that are the main substance of scientific researches, and how to use results of researches in practice within the framework of technology and production. What to do to secure an optimal affect of science on the cultural development of society and material basis of its existence.

At present these problems are even more important since education, science and technology become more and more indispensable for further and more complex development. Whereas social costs of R+D and education become a more and more prominent constituent of general expenses of social and economic development.

For this reason, the control of science has got a more and more important role in the countries which accepted planning, that is, bringing into harmony and optimal predicting of all elements of the course of action, as one of the essential factor of their development.

For example, in socialist countries and, so, also in Poland, it is the task of science and technology to solve the fundamental problems of social and economic development and thus science and technology are the leading factors in creating future. In this way, science in Poland and other socialist countries, gained great significance which also involves great social responsibility. Work of a scientist has become not only a means of satysfying cognitive passion and paid work but also a social mission.

Similar evolution trend in establishing the role of science and technology can be observed in all other countries although not always there exists a reasonable ideological and theoretical justification for such an approach to the role and responsibility of science. It is a well known fact that not only socialist countries but also countries basing their economy on free competition and free creativity have long established definite policy in science and central state organs appointed in order to form and realize this policy. It occurs in the USA, Great Britain, France, West Germany, Italy, Japan and many other countries.

Even in science itself, the opinions on the role of control, that is, managing and organizing are subject to changes. More and more difficult and complex goals put forward to

science require the cooperation of more and more numerous teams of specialists in science and technology. It often occurs that thousands of people are employed in large research programs for the whole country.

Since tasks are very complex, huge numbers of specialists and teams are employed and the responsibility for obtaining the desired result and their efficient use is very high. In the sphere of research, development and applicatory activity it is impossible to employ the method of the slogan 'things will work out'.

Science of science and systems analysis provides scientific foundation for establishing an organizing system, adequate to science and technology that would be capable to promote considerably the efficiency and reliability of the influence of science on the sphere of social and economic development of the country. In such an organized system, intuition and randomness must be replaced by rational and objective motivation and methodological systematic approach. In the sphere of science there exists an opinion that even the best organizing system is not capable of replacing scientific creativity but a poor organizing system may decrease, prolong and ruin the profit following from the best creative achievements. This statement suggests that in order to obtain the optimal efficiency in the influence of science on the social and economic development it is necessary to unite properly creativity and organization.

But this is not a union of two equal factors. In the field of science, as generally, in the field of any creative activity, organization must perform the assistant and catalytic role in creative activity and ought to secure the effecti-

veness and profit following from the achieved results. This role must be performed in the manner adapted for the specific nature of science. If organization does not fulfil these conditions it becomes bureaucracy which exerts negative influence on scientific creativity.

From the point of view of creators of achievements, organization, first of all, should not impede in concentration, indispensable in their creative work. They expect good organization to help them in overcoming difficulties appearing in the sphere of conditions and means necessary for scientific work.

Then, the whole organizational system of scientific creative work must be established in the full consciousness that its existence and activity have got sense only when creative activity exists and develops within its frame.

2. THE DEVELOPMENT SYSTEM: RESEARCH-DEVELOPMENT-PRODUCTION-USE (R-D-P-U)

In order to present main problems of the development of scientific and technological creativity and application of its results, one should realize that this creativity forms a part of a more general developmental system
This system includes:

- R - research, the aim of which is the discovery of new phenomena, laws governing these phenomena and the optimization of control and utilization of these phenomena;
- D - development work, the task of which is preparation of plans of innovations, examination of the perfection and usefulness of these innovations and the preparation of these innovations for production and for general use;
- P - production, which is to supply products of the required quality in an adequate amount and at appropriate time, with the highest possible productivity and at the lowest possible social cost of production;
- U - propagation and utilization, which means efficient distribution and rational utilization of products in the national economy and by individual people.

There exist simple and reverse interconnections between these four components of the developmental system generally

referred to as feedbacks. This means that each component of the system acts on the next one but it can also be subject to the influence of the latter /dashed/.

As a rule, there does not exist a fully self-contained developmental system on the scale of one branch, or even the whole national economy of a state. Contacts with science and technology of other countries ought to be common.

This is why, at the stage of research (R) the creators of science and technology avail themselves of world achievements (W_1) as well as themselves contribute to the enlargement of the resources of all-human knowledge (W_0).

At the stage of development work (D), too, one avails oneself against payment (licences, know-how) or free of charge (exchange of information, cooperation) of foreign accomplishments (W_1). Conversely, part of the preparatory work can be exported abroad as a less or more materialized creative thought.

At the stage of production (P), one avails oneself of foreign supplies of various materials, subassemblies and semiproducts. In exchange, part of the production is exported abroad (W_0).

At the stage of distribution and utilization, there exist similar links with other countries. Imported goods are introduced to the market (W_j) while surpluses can be exported.

In each of these components, human collectives are functioning, which must be reinforced with new personnel. The diagram illustrates this by deriving the new personnel from the education system E.

Whole this system can be controlled in a variety of manners, less or more comprehensive and obligatory.

Within this developmental system and with regard to the existing interrelations one can examine on a narrower scale, the subsystem of scientific and technological creativity

In this system, an appropriate consolidation of the personnel means and conditions for the implementation of the assigned tasks leads to creative work. The effects of creative work may include all or some of the results. They are: discoveries and laws governing them, classified among cognitive effects; optimization with mathematical modelling, which, depending on their originality, can be classified either as cognitive or applied effects. Innovation projects, and after their execution also research, and later the technical organizational preparation of production are results of technical creativity, referred to as development work.

3. SCIENCE POLICY OF THE STATE. ITS CONTROL ORGANS AND THEIR FUNCTIONS

At present, in many countries, there have been established national organs authorized to control the development of creative scientific and technical activity and to utilize the effects of this research. These organs substantially differ from one another as regards the legislative foundations of activity, organizational forms as well as the methods and manner of activity.

The decision-makers in these organs include scientists as well as people in other fields. In some of these organs, the role of scientists and their self-government is strongly emphasized while in others - the role of politicians and economists.

Characteristic in this respect is a statement by a former British Minister of Science and Technology, Hailsham, who said in the 1960's:

'A considerable part of the people, considering the needs of science in relations with the government, is wrongly astonished by the fact that those persons who are to make important decisions in the government and therefore must get in touch with technical questions of great weight, do not have either appropriate general education, or professional experience which would provide those persons with respective qualifications for such actions. This is a very important problem, but its solution cannot be left exclusively

to science, or even parliamentary democracy (...). There will always exist many questions to which ministers who are not qualified experts in a given field, will not be able to give answers on the basis of their own experience. What is more, even within the boundaries of the natural sciences, specialization is so great now that it is dubious whether a single man can be found, who could authoritatively speak about something more than only a limited part of a certain domain.

Thus one should not be wrongly worried by the fact that we are governed by 'amateurs', and it is not worthwhile to look for a scientific genius who could replace all of them in the capacity of an 'eminence grise'. What we need is an ordinary administrative apparatus, headed by a minister, which collectively would be able to single out definite matters, to discuss them with competent people, both inside and outside the government apparatus, who can ensure understanding for matter-of-fact arguments and inspire, at various levels of authority, methods of arriving at rational conclusions, taking into account the actually available collective and the attainable and appropriate material means'.

In this statement, convincing is the thesis that the scientific qualifications of people performing decision-making functions in national organs do not play a decisive role in the accuracy and efficiency of the pursued science policy.

On the basis of diversity of organizational forms of national science policy organs in various states and in the light of rather frequent changes of forms and powers of such organs in certain states (e.g. in Poland), one can

arrive at the conclusion that the organizational form alone, not to mention the name of a national science policy organ, does not exert essential influence on the efficiency of its activity.

The most important are always functions which the science policy as a whole, is to perform as well as the ways of performing these functions.

Therefore, in order to select main problems of improving the control of scientific and technological creativity, it is unnecessary to seek differences and their causes in the forms of national organs. It is important to determine common features of the science policies of various countries and, against this background, look for line and ways of further improvement of this policy.

Proceeding in this manner, one can notice that the following functions, less or more clearly and obligatorily outlined, appear in the science policy of every country

- assignation of the lines, tasks and objects of creative work;
- preparation and winning of creators and organizers of science and technology;
- securing material means and creating favourable conditions for creative work;
- actions aiming at the best possible and most rapid utilization of scientific and technological creativity.

One can also notice that the forms and means of activity are identical, irrespective of statutory differences

between national science policy organs.

These are usually:

- various legislative acts ;
- financial incentives;
- pursuing of a definite personnel policy;
- creating moral incentives and influencing scientists awareness.

The purposefulness of the mentioned functions of science policy and its means of action seem indisputable. Therefore, they can be recognized as a field of necessary improvement in various countries.

On the other hand, organizational forms of the realization of functions and means of action of science policy not only can, but, as it seems, should take into account the peculiation of a given country, its traditions, characteristics of its system, political and economic ties with other countries and many other factors.

The science policy of conjoined groups of countries has an increasing significance in the formation of appropriate national science policy organs. An example of this in Europe is the science policy of the Council for Mutual Economic Assistance and of the Organization for Economic Cooperation and Development.

Regional conferences of ministers of science and technology, periodically organized by UNESCO have a certain role in the unification of the notions and functions of science policy and of its national organs. So far, such conferences have been held in Latin America (1966) , Asia (1968)

and Europe (1970).

The process of organizational changes in science cannot be regarded as a finished one. One should consider, however, that every organizational change in science and its supreme control has for some time had a negative effect on scientific creativity. Therefore, it is necessary that the reforms in the system of science and technology and in its national organs fulfill the condition necessity and efficiency.

According to Jan Szczepański*/, before taking up the realization of the above mentioned reforms the following questions ought to be answered:

1) Why do we want to change (reform) a given system? With what phenomena are we dissatisfied and what do we know about the causes of these phenomena?
2) What state do we want to achieve ?
3) What changes in the system do we propose ?
   How can we be sure that the proposed solutions will be better than the present ones, that they will yield the expected results (scientific, economic, social)?
   What system of measures do we have, which permit us to predict whether the proposed changes will be functional?
4) How should non-scientific systems (in the economy, politics, state administration, education, etc.) function in order that scientific systems could attain the goals assigned to them and exert the desirable influence on the substantive development of science (development of scientific creativity) and the development of society ?

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*/ Professor of sociology, Vice-President of the Polish Academy of Sciences

5) How do we plan to prepare the implementation of reforms ? This concerns, in particular:

6) How to prepare the people, inform and convince them as to the intentions of planned changes and the aims which it will be possible to achieve; indicating what would change and what would not change in their situation, in their strivings for the realization of personal aims, interests, etc..

7) What are the indispensable material means, investments, training of personnel, preparation of normative acts. All this is of fundamental significance for the attainment of the objectives of reforms and for proper functioning of the system.

8) How much time is needed for contriving a reformed system and carrying it into practice.

One cannot deny the evolutionary needs in controlling science and technology in a country where the above test gives convincing replies.

The point is, however, that consideration and a prognostic analysis should demonstrate that benefits gained from changes will be incomparably greater than losses caused by reorganization.

4. CHARACTERISTICS OF THE POLISH SCIENCE AND TECHNOLOGY CONTROL SYSTEM

Polish system for the management of science and technology valid from 1972, reveals certain particular features apart from these common to all socialist countries or even common to the systems of another countries with developed science and technology.

One of common features is the so-called vertical structure of science; this means the division of organization into three vertical sections embracing the universities and the technical institutions subject to several departments (as Ministry of Science, Higher Education and Technology, Ministry of Health and Social Welfare, Ministry of Education, Ministry of National Defence), scientific establishments for the research and development (bureaus of project and construction, research institutes), that also belong to many departments, mainly economical.

It has been assumed that within nearest 15-20 years the vertical structure of Polish science will be maintained, with simultaneous growth of integrational tendencies.

It means on one hand <u>functional integration</u>, that is strengthening of horizontal connections by the national plan of research and development works, as well as by the coordinational role of a dispositional centre, controlling the whole scientific and technological policy of the state. Such a centre is in this country Ministry of Science, Higher Education and Technology.

Therefore the main goal of functional integration is creating the situation in which every great scientific problem (involving the investigation programme of the state importance) is solved in the cooperation of the nation-wide scientific potential together with the development of organizational integration. This means permanent or temporary association of the whole institutions or their parts, subject to different vertical departments. Further it means the creation of multifunctional scientific or research institutions connected with industrial corporations and the creation of commonly accessible laboratories and research institutes.

There is also a common tendency towards integration of the research on the international scale, among others on the scale of the countries - members of CMEA. It is obtained by coordination of research plans or the creation of common research programmes (the best example here are common programmes of polar and space investigations), creation of common institutes, laboratories and centres of research, e.g. International Laboratory of Strong Magnetic Fields and Low Temperatures in Wrocław and the Banach International Mathematical Centre in Warszawa.

The Polish model of investigations control is characterized by a particular role of the Polish Academy of Sciences. Therefore, on one hand it is planned to strengthen the co-ordinating function of the Ministry of Science, Higher Education and Technology in respect to economic departments in the field of realization of state projects of the development of science and technology. On the other hand however,

it is planned to strengthen nationwide functions of the Polish Academy of Sciences, among others in the range for control and development of scientific creativity, by means of nationwide plan of fundamental investigations, which is coordinated by the Academy. The Academy cooperates also with the state authorities in the matters concerning the role and organization of Polish science, acquaints the state authorities with reports on the state and needs of science, proposes methods appropriate for proper development of particular branches of science.

The growth of this function of the Academy is expressed in the development of advisory, expert and prognostic activity as well as in special role of corporate bodies of the Academy and first of all a particular role of scientific committees in the appreciation of the state and needs of science in programming the directions of development, determination of these branches of science in which specialization is needed and in the field of appreciation of the results of scientific investigations, the level and quality of scientific staff and scientific publications.

This peculiar (special) position of the Academy results from the understanding of the meaning of competent opinion in the matters of science and its needs as well as from endeavours for the better use of knowledge, talents and experience of the outstanding scientists belonging to the Academy or gathered in its scientific committees, scientific councils of institutes and in scientific editorial boards. It is difficult to define formally these 'non-admistrative' forms of

control by the Academy. Therefore mutual relations between PAS and the Ministry of Science, Higher Education and Technology are better regulated by the principle of close cooperation than by a formal division of competence.

The range of this cooperation is very wide. It embraces among others:

- common responsibility for development of fundamental investigations and realization of the nation-wide plan of these investigations,
- participation of members and workers of PAS in teaching and education of students, in the improvement of academic programmes and methods of teaching, in the preparation of academic textbooks and production of apparatus needed by universities and institutions,
- participation in educating scientific staff by a system of common doctoral studies,
- protection of the scientifically talented young people,
- system of scientific training (practice) in institutes of PAS, summer schools organized by PAS, courses and instruction conferences as well as the activity of PAS Free-University.

Stimulating the circulation and exchange of scientific staff is also very important. It is realized in part by a system of contract engagement of workers of universities in institutes of PAS and workers of PAS in the universities.

At the present stage it acquires a particular meaning in the strengthening and broadening of forms of self-estimation of advances and achievements in scientific research as well the estimation of the quality and level of scientific staff.

The formely mentioned tendency towards extending the autonomy of science and better use of nonadministrative forms of controlling science corresponds with the development of the social scientific movement. It includes very numerous in Poland scientific societies, general and specialistic, as well the scientific and technical associations belonging to NOT /Chief Technical Organisation/, scientific and professional associations of physicians, economists, architects etc. Active members belonging to the social scientific movement constitute approximately half a million persons. This movement disposes of a well developed organizational network and constitutes a powertful tool of dissemination of science and scientific outlook on life according to the needs of formulating a well developed socialist society. Therefore the activity in this range tends not only towards such a formulation of human mind which would correspond with the needs of the contemporary science but also to such a formulation of personalities and attitudes which would enable understanding of the contemporary world, and full awareness of the role and responsibility of a man in the civilization created by science and technology.

5. SOME PROBLEMS OF THE SELECTION OF RESEARCH GOALS AND TASKS

An extremely important role is played by organizational aspects in the field of defining the goals to be achieved and the tasks to be carried out. I wish to emphasize only a few selected questions among the numerous problems in this domain.

The division into cognitive and applied research (diagram 10) is of a theoretical rather than practical significance. This is so, first of all, because in many instances it is difficult to draw the line where the former type of research ends and the latter begins. It is important, however, to single out basic research, conceived as being of fundamental qualitative significance for the development of science and economic and social practice. In such a sense, basic research should have the traits of cognitive research, but it can also embrace applied research of special weight.

On the basis of the to-date observations of both the domains of basic research and the field of applied research and development work, one can express the view that we still insufficiently avail ourselves of the influence on the executors of the 'power of a great goal'. The power of a great goal releases among participants in the implementation of a programme great forces of internal involvement, and energy indispensable for overcoming difficulties and in the process of the implementation.

Principally, in each government programme one can find, for a given period of time, tasks of the character of a national programme which mobilize both the forces of scientists and specialists in various fields as well as the co-participation and interest of society, and especially the youth. In Poland, for example, the comprehensive development of the Vistula-River is a programme of such a character. In the food programme - the utilization of oceanic proteins; in the fuel and energy programme - the chemicalization of coal and utilization of energy from the nuclear thermosynthesis reaction, in the regional planning programme - the turning of the Mazuria lake district into a fully modern feeding and recreational area, etc..

It is advisable that this principle be applied as broadly as possible in remaining national programmes, i.e. concerning key problems, in inter-departmental programmes of the basic research. Appropiate informational, organizational and propaganda activities ought to be related to such a 'national programme' in order to include into its realization the most numerous groups of scientists and a wide support of the society.

As regards research and development and application programmes, of foundamental significance is such a formulation of material goals that they be tantamount to a new product, method, or service. There should exist full adequacy between the plans of so-called 'new launchings' in the national economy and research and development programmes. At present, in Poland, especially in the field of key problems, many of these programmes require a reformulation or supplementation of the goals of research and development work. Such corrections in

the contents of plans will permit to confirm the rightness of the opinion about the good system of research planning in Poland on the basis of the principle of comprehensive national programmes. They constitute a proper method of integration of scientific and technical circles, regardless of their organizational subordination, about common goals. Satisfaction with this system will be complete when we fill good 'forms' with good contents of tasks.

As far as the choice of aims for research activities is concerned one should emphasize the dissimilarity and peculiarity of cognitive research.

The aim of this research should be the unknown, which needs to be discovered. Therefore, this aim cannot be defined beforehand. However, it is possible to define the lines of research and, on their basis, formulate research tasks. Implementation of these tasks can be supervised and evaluated. It may happen, however, that results of the implementation of research tasks will be negative in comparison with the intentions or hopes linked with definite lines of research.

The above principles of the choice of aims and lines of research have been successfully applied for a number of years, which confirms the rightness of their formulation.

6. ESTABLISHMENT OF MEANS AND CONDITIONS FOR ACTIVITIES IN RESEARCH AND DEVELOPMENT (R + D)

Organizational problems related to the establishment of suitable means and conditions for R+D are very diversified. These problems must be solved in a satisfactory way to enable the creators in science and technology to conduct efficient activities.

The first group of problems in this field involves problems related to planning and verifying the progress and reports on research.

Planning in R+D is the fundamental organizing process that determines the whole course of activities, their duration and costs. For this reason, much attention should be paid to the planning processes. The appropriately approached planning requires the highest scientific and organizing qualifications. Therefore, some scientists who consider planning only as a bureaucratic necessity are wrong. Of course, planning can be, as any other most useful activity, vulgarized by reducing it to the careless filling of special forms.

If planning is approached and implemented in this way, it can be, indeed, a laborious and unnecessary bureaucratic operation that can be even harmful for effective activity.

We distinguish three regions for planning activities in R+D. In each one of them, it is possible and necessary to apply the requirements of system analysis.

country is, in general, more important. This is reflected first of all, in the selection of utilitarian goals to be achieved by R + D.

The third principle consists in recognizing the priorities in view of urgency and importance. It is a rule that only vital subjects are included into the set of problems to be solved. But even in the most developed countries these subjects are too numerous to be worked out in a satisfactory way. Therefore, the principle of priority employed in the selection of subjects is based on the urgency of the research work. When reasonably interpreted, these principles can be applied in the field of strictly cognitive research .

The succesive fourth principle of 'strategic' planning consists in conducting the largest possible number of R + D projects within a complete development cycle that starts from research activity and ends in applying and spreading out the results.

It is estimated that approx. 70% of the Polish R+D projects are conducted in such cycles. The remaining 30% are included into non-complete developing cycles or general technological activities.

The fifth principle is an endeavour to maximal utilization of foreign achievements. At the stage of 'strategic' planning it is difficult and often controversial to make decisions on this what can be called an operational planning. Here the analysis and selection of optimal ways and means of the implementation begin to play the most important role.

The third region covers the planning of implementation of particular tasks of a single R+D program. This is

a planning of tactical type, that embraces a number of conditional situations related to participation in a large set of other tasks that form an integral entity. In this region of planning, not only the search for optimal solutions is of vital importance but also employing of well suited methods in conducting research or development works (designs, production methods, constructing a prototype, etc.).

Both these regions of planning have their peculiarities and deserve further consideration.

The second extremely important instrument employed for controlling R+D activities is financing. In two countries that do not apply the complex planning of the development of economy and R+D programs, financing is the fundamental factor of control.

While considering only the 'strategic' that is all-country or branch region, it can be noted that two main principles of financing have been worked out.

The first principle concerns the adaptation of the scope of R+D activities to the possibilities of the state budget.

It is a usual practice to compare the expenses for R+D on the international scale as a percentage of the whole state budget. As the matter of fact, this index is not an adequate illustration of the possibilities and scale of R+D activities in particular countries. In this field an absolute amount of financial means with regard to the purchasing power of a given currency is decisive.

The percentage index of the budget for R+D is not, unfortunately, based on the reasonable premises on the actual needs in R+D. It is necessary to recognize that such a reaso-

nable premise is the establishment of expenses as a derivative of the costs in every branch of the national economy. This is so because the R+D activity must be treated as a widely meant preparatory action for production or services.

Unfortunately, the practice of such a kind is consistently realized only by some large industrial concerns and firms. On the national scale only a certain emanation of this method of establishing R+D expenses has been introduced as allowances from incomes or production costs. In Poland, this approach is represented by the Fund for Technological and Economical Progress.

In contrast to R+D activities, it is justified - within the region of theoretical studies - to finance work from a determined part of the budget because this is research of a common or very wide significance. In Poland, this kind of financing is accomplished within the framework of the Fund for Research Work.

The second principle in financing R+D activities consists in the unity of tasks and means. This signifies that financing should concern the entire R+D program, from the beginning of research until the implementation. Only dissemination should belong to the typical production or service programs.

This principle is put in practice in the form of the so-called subject financing (for a program or a goal) in distinction from the object planning (for a centre, R+D and groups of research workers).

The method of subject financing that is e.g. predominant in Poland (up to 70%) has proved to work as being, at some

time, the method of distribution of financial means to particular fields of activities and social and economic needs.

Supervision plays an important and specific role in the control of R+D activities.

In Poland, the interference of an organizational and administrative character into the appraisal of progress in research has proved not to work. Such an approach causes only formal and rough estimation of the progress made in creative activity, complaints aimed at bureaucracy and - this is most important - it fails to provide the sufficiently motivated opinion on the scientific and practical value of the obtained results.

For this reason, in Poland, where researches are conducted for a few years now in accordance to all-country programs, the Polish Academy of Sciences initiated the method of collective self-estimation of the progress in R+D works and of the appraisal of their results.

The method of self-estimation is the consequence of the situation in which all-country programs are attended by all specialists in the field associated with the program. Thus, it is impossible to ask other better qualified specialists not included in this group to perform the analysis and assessment.

The method of self-estimation consists in considering the progress and results of research works at special seminar sessions that are attended by the groups of workers that put programs in practical use. The so-called 'opponent' aproach has been here successfully tested (this is analogy to the function of a prosecutor in legal proceedings).

It follows from the experience gained over a few years, that the method of self-estimation provides good results. Self-estimations are made with a deep insight and provoke sharp polemics and critical comments. This promotes scientific activities and the responsibility of research workers and creative individuals.

Preparation of the so-called signal information belongs to the methods of peculiar verification and substantial reporting. This kind of compact information is provided just after results ending a given stage of work or theme have been obtained. Signal information is written in an easy way to be understood even by non-specialists. Its details are sufficiently well widespread to be the basis for establishing the opinion of authorities and society on the progress in R+D.

Within the sphere of the means and conditions of conducting R+D activities, an especially vital role falls to the development of international relations and cooperation.

International cooperation must be treated as an integral part of fulfilling tasks aimed at meeting the need of the country. In this meaning, it is considerable enlargement of the productive and executive possibilities of the country.

From the point of view controlling and organizing R+D activities, international cooperation should - with a complex approach - include:

- joint research and development works,
- import and export of creative ideas (both scientific and technological) that is, designs, expertises, forecasting advisory activity, etc.

- import and export of the so-called 'materialized' creative ideas, mainly licences and related facilities
- training and improving qualifications of staff members (native workers outside the country and foreign workers at the home country)
- cooperation within the framework of scientific and technical associations both international and national.

Conducting joint R+D projects has got a crucial role among the above mentioned elements.

Joint research is conducted in various forms which are required by the peculiarity of the investigations and organizational situations.

Nevertheless, conducting research work can be classified into four groups that are related to the organizing level, obligatory terms and effectiveness of research:

on the first level that is less obligatory and most easy to be put in practice, only information is exchanged on plans and obtained results of work. This is usually accompanied by the mutual exchange of documentation and publications,

the second level of cooperation in R+D comprises all from the first level and, moreover, the coordination of plans and distribution of jobs between the cooperating home institutes,

the third level of cooperation embraces all from the second level and, moreover, establishment of mixed international groups in the cooperating institutes of the country. The problem where to localize particular groups is solved by taking into account available facilities, scientific potential, staff levels, accommodations and other factors,

the fourth level of cooperation is characterized by the fact that common, permanent R+D centres of a stable nature are established. This obviously concerns the fields in which long term cooperation is possible.

Trips and stays outside the country are important in international cooperation. They are not the goals for themselves but they are only the means for performing determined jobs.

As foreign trips and stays are attractive it is necessary to control them in accordance to the principle of priorities of needs and importance.

In Poland, the principles of priority on the scale of e.g. the Polish Academy of Sciences are as follows:

- the first priority falls, almost always, to foreign trips for research purposes (research trips and stays);
- the second priority concerns educational trips and stays in order to improve qualifications. This is not a numerous group of foreign trips and stays because education is usually connected with research trips and stays. Nevertheless, in some cases, foreign trips and stays can be of educational character, only,
- the third priority covers trips to attend conferences, provide consultations and visits to foreign centres,
- the fourth priority is attributed to trips for organizational and representative purposes.

The foreign trips and stays are associated with the so-called problem of mobility of scientists. The slogan of an unrestricted mobility of scientists propagated by some scientists and statesmen proved to be unrealistic and harmful in the majority of countries. This is profitable only for the

richest countries that are capable of offering very convenient working conditions for specialists. Similarly as most countries, Poland has replaced the principle of the unrestricted mobility of scientists by that of the maximization of the state-controlled exchange of scientists and other specialists.

Apart from securing the means and conditions for conducting current researches, the specific feature of R+D activity is the building of the future executive potential for R+D.

This problem involves, first of all, a long-term policy of the quantatitive and qualitative development of scientific staff and other specialists in creative activity.

It is an extremely vital and complex problem how to improve, strength and develop the structure and network of R+D centres.

This is associated with especially difficult and costly investment, first of all, in the field of enlargment and modernization of buildings. The supply of unique research apparatus is an independent and exceptional problem.

This problem concerns the production of scientific and research apparatus in the country, its international exchanges and appropriate localization and utilization. These problems have not so far been solved optimally in many countries and, for these reasons, they are one of the themes of the most vivid discussions in scientific centres and the objects of the deepest comments on the scientific policy.

It is insufficient to meet, even in the optimal way, the current and future requirements in the field of R+D activity,

if it is impossible to create between the scientists and specialists in technology and especially in the strictly-leading group of creative individuals in these fields - the atmosphere of confidence for those who control the activities of R+D and the atmosphere of active and ideological participation in achieving goals. Therefore, the obtainment of well developed programs and recruitment of main executors are very important tasks in the process of controlling the whole scientific activity.

First of all, these goals should be achieved by including the executive persons into the teams of authors who prepare the programs themselves.

This is the application of the principle of partnership between the decision-making individuals and specialists.
To obtain a permanent existence of the atmosphere of active and creative participation between specialists in science and technology, it is extremely important to perform well organizing functions in establishing goals and tasks and ensuring good conditions for application and utilization of results.
At this point, we wish to mention a certain weakness in our organizing activities that is very unpleasant for scientific workers.

Namely, creative scientific and research workers are excessively and too frequently bothered by typically organizing jobs. If the whole organizing systems functioned effectively, the scientist and, more generally, the creative worker could be unconscious at all of these affairs over the entire time of its creative work. It is a usuall practice that even

the scientific workers at the highest positions in the scientific hierarchy are annoyed and preoccupied by organizing, financing, reporting and similar problems. This state of affairs results partly from the lack of competence of the organizing and administrative personnel.

These poor qualifications disclose the lack of self-dependence and the fear of responsibility. However, this state of affairs is thought of to be - in numerous communities - an unavoidable and necessary evil. Such an attitude is represented in a certain way, by the fact that some centres issued local regulations requiring that scientific heads and creative scientific workers must participate in solving every administrative problem.

Another circumstance that is unfavourable for the good atmosphere for work consists in that administrative authorities distribute between scientific workers unnecessary rumours on the usual but excessively inflated difficulties in realization of programs. Thus, a rumour is spread out between groups of workers who are not concerned at all with difficulties of such a kind. An example of such a rumour is the complaint about the shortage of financial means even between these groups that have no ground for it. An analysis of the progress in implementing basic research projects has indicated that complaints about the shortage of financial means were put forward even by those who had not been able to spend fully the financial means previously allocated to them. They simply repeated the circulating general opinions without confronting them with the actual state of affairs within their own programs.

In establishing a good atmosphere for creative and active participation, it is important to view an individual contri-

bution into the results of collective work. This may be realized by improving the regulations concerned with granting prizes and establishing the principles of appraisal of the author's contribution into publications etc. Something more ought to be done e.g. indicating the significance of even partial contributions into final results of a whole program.

Controlling activities of scientists, partnership, convincing encouragements, thus influencing the consciousness rather than methods of prohibitions and orders are very important for creating a good atmosphere in research work. Therefore, it is more reasonable and purposeful to explain, on training courses, the principles and guidelines of scientific policy and legislator's intentions than supply scientists with numerous decision-making documents.

It should be emphasised here that it is worthwhile to conduct all possible organizing activities within the scientific community by employing - as far as possible - non-conflicting methods. In this way it is possible to avoid the loss of energy and the distraction of the attention of creative individuals by the affairs that can be settled without exciting emotional feelings.

7. UTILIZATION OF RESEARCH RESULTS

Rich experience of many countries indicates that not always the country which has made a scientific discovery or a technical achievement reaps as the first, or reaps at all, the fruits of its accomplishments. It is often forestalled by countries disposing of a more efficient and stronger apparatus for the utilization of scientific and technical innovations.

There are also frequent cases when practically mastered innovations are propagated slowly, which does not allow the society to feel positive effects of the progress on a mass scale.

These two observations emphasize the specially great significance of an application and propagation of results of research and development work as well innovation resulting from discoveries. Even the best choice of aims and tasks and the best conditions for the implementation of tasks and the attainment of goals, i.e. the optimum execution of research and development work, is not sufficient unless application and adequately broad dissemination of results of this work takes place without delays.

This indicates the <u>indispensability of possible closest relations of R+D work with application and propagation.</u> Hence this question must also come under the scope of science policy although <u>realization of application and propagation is the concern mainly of national economy units</u>, and not of the scientific-technical base. However, there is need here for appropriate cooperation of both partners.

The practice of many countries, Poland included, shows that application and propagation constitute the least efficiently functioning link in the development cycle. In this connection, attempts are being broadly made to increase the efficiency and effectiveness of methods, and especially of application.

Also in Poland a comprehensive programme of application has been worked out, which assumes that ways of influencing the improvement of efficiency and effectiveness of application and propagation should concern national economy units and units of the scientific-technical base and ought to be of an organizational-planning, economic and moral character

The division of ways of influencing the effectiveness of application into these three groups is a matter of order. For in practice, ways from all three groups are usually applied at the same time.

Organizational-planning stimulation (~~diagram 22~~) plays an especially significant role in the countries which base their economy on planning. Some elements of this type of stimulation, however, can be applied, though on a limited scale, in various socio-economic systems, irrespective of the political system.

Experience has demonstrated that one of the most effective ways of stimulation of applications is the establishment of mixed teams for research and application, composed of both authors of achievements as well as workers of the factory who are to utilize and apply a given innovation.

Direct contacts and cooperation between the researcher and the designer are particularly important. The latter means both the desinger of building investments, the constructor of new installations and products as well as the technologist designing technological processes. Designers of all kinds have one common feature: they exert the most immediate influence on the creation of the real shape of innovations, they determine in what way people can make use and feel the benefit of scientific discoveries.

The designer, next to the decision-maker, who makes decisions concerning application, is the most important partner of the author in the practical utilization of the latter's scientific accomplishment.

The most effective and most indispensable for carrying out application are purchase and building and assembly investments. Therefore, for effectiveness of applications, a close coordination of the plan of research and development work with the investment plan and the plan of so-called new launchings of production is necessary. This means that the predicted applications should have appropriate support in investment plans. This condition stems from the fact that an overwhelming majority of results of R+D work cannot be applied without bigger or smaller investments.

The scope of investments in new plants or in the modernization of such investments determines the technological level for many years. It is therefore very important to create the conviction of the indispensability of imbuing every investment with innovations to a maximal degree. Investment projects should be evaluated from this point of view by teams of specia-

liststs. Only investments appraised positively i.e. which obtain the so-called clause of modernity, should be admitted for execution. Actions of this kind enhance the interest and demand for research achievements and innovations.

Similarly conductive to the demand for research results is the linking of programmes of 'new launchings', i.e. new or modernized products, with research programmes. Practice in the field of applications shows that each item in the programme of new launchings in production plants should correspond with respective orders of component units of the scientific-technical base for research and development work, aimed at the introduction of a new product, modernization of a given product.

A social sense of innovation exists when an innovation is propagated on a mass scale. The greatest innovations, introduced on a limited scale, do not bring general social satisfaction. It is therefore important to subject the programms for new and modernized products to social control. The time of propagation, its scope as well as the prices of innovations should be subject to such a social control.

Methods of economic influence on applications and propagation are especially universal and generally effective.

Among methods of economic influence, the most significant are these which directly influence not only people who are the authors of accomplishments, but also the whole teams concerned with application on popularization. Thus this

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*/ The variable, as distinguished from the permanent, part of remuneration, dependent on many criteria

concerns making bonuses [*] dependent on the prompt and qualitative implementation of application and tasks and rewards, determined in advance and dependent on the effects obtained from a given accomplishment within a fixed period of time.

Another economic factor which should favourably influence the time and number of applications is linking the price system with renewal and modernization of production. Attempts are made to elaborate a system of the so-called cascade prices, i.e. prices diminishing with the time of production of a given commodity. Therefore there have been proposed prices of novelty , ordinariness and antiquation, the periods of which will be dependent on the kind of a given product and with which a declining rate of profit will be connected.

In this way, the continuation of production of commodities with prices will be unprofitable for the producer, and this should prompt him to introduce a new or improved commodity.

In order to protect oneself against this only seeming modernization and an unjustified increase of the cost of production, 'planning-making' countries have introduced stiffer technical requirements (categories of technical level A, B and C and of quality Q and 1) for new products and intend to introduce the principle of comparability of sale prices with the strongest competitor on an international scale.

In the case of mass articles it becomes necessary to closely connect the system of retail prices with periods of novelty, ordinare and old products.

Moreover, many other stimulators of an economic nature can be introduced, which should create an atmosphere of demand ('suction') for innovations promoting technical progress.

One of them may be the introduction in the calculation implementationed undertakings of the account of labour costs plus the so-called general consumtion fund, which in conditions of Poland, for example, means an increase of the share of labour costs by about 30 per cent.

This should contribute towards lowering the limit of profitability especially in the range of innovations connected with automation, which usually ensures savings in labour.

In order to develop the undertakings aiming at raising the efficiency of the application and dissemination process it is necessary to improve the method of determining the efficiency and profitability of the research and application work, consisting in introducing the above mentioned principle of social effectiveness. This means that is necessary to determine the resultant effects which a given new product brings to the producer and the user. For it sometimes happens that some innovations actually bring benefits to the user, and not to the producer.

Various moral methods of stimulation are significant for the time and scope of the implementations.

The most important thing is the realization of a collective and universal conviction that applications constitute an integral and necessary part of the preparation of new or modernized production. Consequently, the

realization of this conviction must be connected with analogous incentives and sanctions as in the case of production. This means, for example, that delays as well as lack of application undertakings should be regarded as a failure or a delay in carrying out the production tasks.

One should recognize as fully justified the application of social forms of distinction of the authors of important innovations and of workers setting an outstanding example in the application and propagation of these innovations. This is connected with the problem of the so-called anonymity of authors of many achievements which are subsequently disseminated on a mass scale.

Generally speaking, the appraisal of the management and technical personnel should be based to a growing degree, on their participation in the application of innovations. Briefly, there is need to apply the criterion of innovation in the appraisal of conceptual workers of production plants.

The above remarks and reflections on the subject of application and propagation concern mainly research and development work conducted within the so-called full developmental cycle, or comprehensively, from research to practical application.

With regard to work of an exclusively scientific character, the notion 'application' must be appropriately modified. It can be replaced with utilization of research results in creative technical work. For example, as 'applications'

should be regarded the results of theoretical studies and research on the anisotropy of resistance of certain plastics if these results have been utilized in designing of constructions and have brought appropriate savings in materials and an increase of the coefficient of the safety of construction.

Generally speaking, in the case of cognitive research the proper forms of transmitting its results should include also publications, introduction of durable achievements in lectures and other forms of instruction, in manuals and other teaching aids. All forms of scientific guidance, such as expertises and forecasts, should be regarded as valuable and desirable forms of utilization of the accumulated scientific knowledge for the application of innovations.

Of course, there remains the possibility of participation of the authors of achievements of cognitive research in the application processes, e.g. in mixed teams of authors or in some other forms. Such examples are ever more numerous, which indicates that there are more and more scientists who not only in their convictions but also in actions demonstrate that the role of the researcher is not only to create but also to transfer research results to practicians in all available forms.

8. CONTROL OF THE DEVELOPMENT OF SCIENTIFIC AND ORGANIZATIONAL PERSONNEL

The decisive factor and, at the same time, the subject of the innovation process is man, his attitudes, qualifications and actions. Therefore, the problem of scientific personnel, and of creative and organizational personnel in general, should be ranked among the most important elements of the development strategy of science and technology as well as of personnel policy.

The system should embrance all categories of workers who are indispensable for the development of science and also for saturating with elements of science and scientific methods all sectors of the national economy and national culture. This concerns research workers of all categories (professors, adjuncts and assistants), scientific information and documentation workers, engineering-technical workers, workers of the planning, administrative, economic and financial services as well as workers with scientific qualifications employed in non-scientific institutions.

The creator, the researcher and the designer ought to be the main persons in the personnel policy. Therefore, we shall devote the remarks presented below mainly to research workers.

Thus there appears a basic question who can be a scientist-researcher ? what criteria should he or she fulfill?

Considering the great role of science in the totality of our life, one can, as it seems, thus formulate the conditions for being a scientist

- a genotypic condition: outstanding intelligence, without which no creative achievements are possible,
- an indispensable condition: dedication to an idea, shaped in conformity with the supreme patterns of humanism,
- a necessary condition: profound scientific erudition,
- a constitute condition: continuous creative activity as the main feature of a scientist,
- a subsidary condition: the conviction that, next to creativity, the other fundamental duty of a scientist is the transmission of research results and of the whole accumulated scientific knowledge in general.

Among the above-listed requirements, a few words should be said about the condition briefly termed dedication to an idea. In connection with the growing number of scientists and the increase of their social function, creative commitment is significant, resulting not only from knowledge, but also from the conviction that it is the intellect and science that actually pave the way for the development of mankind.

This should give rise to an internal conviction that the work of a scientist is an important social mission which demands readiness to surmount any difficulties in the introduction of the objectiveness of scientific truths in all fields of life. A candidate for a scientist should feel and be convinced that he will be able to perform such a mission.

And this means that actions of a scientist must be guided not by a pursuit of material benefits and the vanity of commendations and distinctions, but by responsibility to the society, to the nation and mankind.

Therefore, every scientist must constantly attempt to make himself and his life a versatile social model, not only because of his erudition and creativity, but also in any other respect.

Of course, one can doubt whether the already numerous part of society professionally practicing research and scientific work will consist exclusively of profoundly ideological,moral and ethical individuals. It is important, however, that the number of such scientists be large enough, so that they be the most active group, stimulate others by their activity, set a live example of the ideal of a scientist and man.

Another question that requires a few words of interpretation is the problem of erudition.

Present-day methods and ways of creating science and of its social utilization demand from researchers and other categories of workers all-round intellectual qualifications and abilities connected with the diversity of social functions and roles fulfilled by them. Thus the system of education

further training of research workers should embrace such questions as the knowledge of the organization of research institutions, science, policy, methods of management of research institutions and teams, the morality and ethics of scientific work, the law regulating the functioning of science, methods of financing science, etc. We have initiated such education within the framework of the University of the Polish Academy of Science.

Assimilation and accumulation of scientific knowledge through the whole life is the foundation on which creativity can develop. The practice of life shows that there are cases when scientists fall into extremity in this field.

Depending on the type of work, scientists represent two kinds of knowledge specialized knowledge and encyclopaedic knowledge. However, when a scientist excessively narrows down his specialization, seeking to increase the profoundity of his knowledge, he comes close to the infatualist, or a man engrossed by something extremely narrow and confident that he has an absolutely full knowledge in this domain. Briefly and ironically, an infatualist is said to know everything about nothing.

Another danger arising from the accumulation of knowledge is excessive encyclopaedism. It can lead in consequence to a shallowing of knowledge, and thus to dilettantism.

The problem that appears in the education and self-education of a scientist is to be able to choose and assimilate knowledge in such a manner as to remain in the interval proper of a specialist who knows very much about the main problem

and has adequate knowledge of the related problems.

And if one wants to widen the scope of scientific knowledge, it should be done in such a ways as to remain in the interval of an encyclopaedist who knows much about many problems.

Where to find such candidates for scientists, for creators of science and technology who would be able to meet the above-mentioned conditions? We tackle here the important problem of discovering talents and selecting candidates for scientific workers.

The process of discovery of talents and initial selection of candidates for scientific workers takes place too late, most often in the course of higher learning. Studies of the careers of winners of competitions for secondary school students have shown that higher schools take little interest in them, and they form the best group of candidates for scientific workers. Unfortunately, the selection for scientific workers is frequently based on accidental factors, such as the place of residence, living and material conditions, etc.

There exists a natural field for recruitment in schools, from which scientific institutions pick up their candidates.

The system should act toward widening this field and increasing its effectiveness.

For example, very good and outstanding pupils of primary schools are natural candidates for workers in scientific institutions. Over 50 per cent of the graduates of those schools continue their education in basic vocational schools. Among

the graduates of the latter there is a large percentage of greatly talented students, but only a small number of them continue their education.

About 18 percent of primary school graduates go to general secondary schools, 70 percent of them are girls. And these schools supply over 50 percent of candidates for higher schools. This fact excludes from the field of recruitment many talented people fit for work in research institutions.

An additional natural field of recruitment are hobby circles existing in schools of various types, scientific circles in higher schools and students scientific camps, conferences and congresses organized by the student scientific movement.

All these forms should be taken into account in the science policy concerned with formulating the field of recruitment of candidates for scientific workers. So far only higher studies have formed such a field.

In recent years the Polish Academy of Science has been looking for especially talented youth in the two final years of study. At present, 0.4 percent /4 per mill/ of the students of the last and penultimate year of study have been selected, who have been granted special scientific scholarship and embraced by the scientific care of the Polish Academy of Science. Those students undergo summer training in the Polish Academy of Science units, are invited to scientific meetings, enabled to prepare dissertations for a master's degree, assigned individual tutors, etc.

The to-date statistics show that about 60 percent of the candidates selected take up scientific work (two thirds of them in higher schools) while the rest choose other professions.

It is still too early to formulate general conclusions and appraisals of this system. It appears, however, that further improvement of this system, is indispensable and should lead to good results.

A successive problem in the field of personnel policy of scientific workers is their preparation for independent scientific work (the question of creating the genotype of a scientific worker).

This problem concerns the postgraduate period only. In the course of undergraduate studies the preparation of scientific workers is unfeasible since it is not known in advance who will become a scientific worker.
Moreover, the percentage of graduateswho take up scientific work is very small.

Therefore, the only thing that can be done for students 'suspected' to become scientists in the future, is to permit them to pursue their studies according to individual curricula.

However, proper preparation for scientific work must take place only after graduation.

The education of scientific workers in Poland takes place in a form of doctoral studies and assistantships.

These two main ways of education are being constantly improved and modernized. Mistakes of the initial selection

for doctoral studies are being corrected, which sometimes eliminates promising candidates for scientific workers. Information on the course conditions and possibilities of such studies is widespread among students there is a principle that those who begin doctoral studies should know in advance the subject of their doctor's dissertation.

Assistantship is a form of training for all kinds of work and functions which a scientific worker will have to perform. At the same time, an assistant, seeking to win a doctor's degree, can attend doctoral seminars.

The parallel maintaining of the two ways of winning a doctorate and taking up scientific work professionally, requires a harmony of these ways and creating equal opportunities. An assistant usually has a more difficult situation, but on the other hand he grows into his institution and has a fixed position in it while a person studying for a doctorate does not always know where he or she will work afterwards.

Irrespective of the way by which a young scientific worker arrives at the doctor's degree, he should learn everything that is necessary for his future profession. Therefore, in the course of assistantship he must obligatorily attend a course in the methodology of scientific work, and while being a senior assistant - a course on the transmission of research results and knowledge as well as on didactics.

In this way a young scientific worker is being prepared to be able to create and transmit knowledge.

A very important question in the control of personnel policy of scientific workers is their promotion

At present, there exist three ways of promotion in Poland. The first type of promotion is most directly dependent on the scientific worker himself: it is the winning of scientific degrees: doctor of science and doctor habilitatus.

The second type of promotion - the main one, involves scientific posts, two of which are at the same time highly valued scientific titles (extraordinary professor and ordinary professor). This kind of promotion constitutes a specific scheme which principally is designed for the whole period of active scientific life.

The third type of promotion is of an organizational character basic levels of this type of promotion: head of a section, division and institute.

Scientific promotion, e.g. scientific degrees, titles and posts, was conceived in such a manner that scientific achievements should be the decisive factor. In practice, however, it often happens that not creative work but precisely these 'levels of promotion' are an end in itself. Creative work is done and valued only inasmuch as it may bring the possibility of promotion in the scientific or organizational hierarchy. The reason behind this are material benefits as well as privileges and dignities connected with climbing the ladder of scientific or organizational posts. Thus the problem remains open, what to do in order that the main goal in the pursuit of promotion be creative work and scientific accomplishements in general.

On the other hand, however, in order to put into life the postulates concerning improvement of scientific work and increase of its efficiency, there is need for people who will be able to direct these tasks. In other words, there is need for good organizers of creative work.

Who are to be those organizers?

Part of them have the powers of decision-makers at respective levels. Thus they are managers. There is a disagreement as to the fact whether a manager must simultaneously be an outstanding specialist in a given field of activity and a good organizer, or whether the abilities, knowledge and skills of an organizer are sufficient.

In the domain of basic research the conviction prevails that a manager of scientific work should be at least a good scientific worker, and it is desirable that he is an outstanding scientific authority. This opinion is reflected in the slogan, often repeated in the academic circles, that 'directing science means creating science'. This expresses the view that directing scientific work requires also from the manager his personal creative engagement.

In practice, however, a combination of great scientific values and organizational talents and skills in one person occurs not very frequently. The reason for this is, inter alia, the lack of adequate organizational training. In a situation when it is necessary to decide whether to designate to a post of a manager a scientist with rather low organizational qualifications or an outstanding organizer with poor scientific quali-

fications the first possibility is chosen in the field of basic research. In such a case, however, a well-qualified organizer should be assigned to help the manager.

On the other hand, in large organizations, especially of the development and application type, organizational values play a very significant role, and the second alternative may prove to be more justified.

Certainly, in each case the ideal solution is a combination of the highest scientific and technical qualifications with high managerial and organizational qualifications.

In order to secure proper coordination of the promotion policy a univocal relationship between various ways of promotion is indisponsable. Such a relationship is difficult due to great differences occuring in many cases between scientific and organizational qualifications. Thus a section can be headed by a doctor of science or a doctor habilitatus who holds the scientific post of an associate professor to adjunct, and exceptionally - a senior assistant. A division can be headed by a doctor or doctor habilitatus who holds the post of an associate professor to docent (exceptionally the post of an adjunct). A candidate for the head of an institute principally must be a professor, but exceptionally also associate professor.

The continuity of managerial functions and scientific creativity, always should be preserved, this is why it is very important to prepare the staff of successors. This means not only present deputies of the scientific and organizational personnel but also the workers at least 10 years younger than

those whom they are to replace. This permits, because of the difference in age, to eliminate conflicts and competition in relations between those who are holding posts now and their future successors. This also gives the time for their adequate preparation from the viewpoint of both scientific and organizational qualifications.

The Polish Academy of Science is now beginning to set up a system of training of organizers of scientific work, similar to the existing system of scientific training.

Candidates for this training should hold at least the post of an adjunct.

The aim of this organizational training is that organizers of science, would acquire their knowledge not their own mistakes, which is the most expensive method, but by the necessary qualifications and skills acquired by education.

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In my paper I have tackled certain problems of the control of development of research, utilization of its results and preparation and work of scientific personnel. Because of the time limit I have not raised many problems which also should be ranked among essential questions of the control of the domain of science and technology.

I believe, however, that even on the basis of a limited review of these problems one can arrive at the conclusion that many countries face similar problems and difficulties. Therefore, the exchange of experience and views on the systematic approach to these problems and their resolution, at our conference will be very necessary and certainly useful.